Micheline Andel Goldwire, MS, RPh
Ms Goldwire received a Bachelor of Science degree in Pharmacy from the University of Texas in 1988. After graduation she completed an American Society of Health-System Pharmacists accredited residency in pharmacy practice at the University of Texas Medical Branch in Galveston, Tex. She practiced one year as an oncology pharmacist at the University of Wisconsin Hospital and Clinics in Madison Wis. She moved to New York City and in 1992 received a master of science degree in drug information and communications at the Arnold and Marie Schwartz College of Pharmacy. During this time, she also completed a 2-year fellowship in drug information, under the leadership of Mack M. Rosenberg and became involved in sports pharmacy. With direction from Dr Rosenberg and Robert Fuentes, she assisted in authoring the Allen and Hansbury's *Athletic Drug Reference*. Ms Goldwire has spoken at several national conventions on the subject: ASHP Annual Midyear Meeting 1992, New England Council of Hospital Pharmacist National Meeting 1993, and the Baylor College of Medicine Annual Pediatric Conference 1994. She has also authored several articles on the subject. Currently she is also a Clinical Instructor and Regional Coordinator for the University of Texas College of Pharmacy Externship programs and holds an appointment with the University of Houston College of Pharmacy.

Key Words

- anabolic steroids
- athlete
- drug testing
- ergogenic
- erythropoietin
- growth hormone
- stimulants

Athletes may use many different methods to gain a competitive advantage. One method is the use of ergogenic (performance-enhancing) drugs. Ergogenic agents include anabolic steroids, growth hormone, and erythropoietin. Stimulants may also be used as ergogenic drugs because of their ability to mask fatigue. Some athletes also use drugs that prevent the detection of ergogenic drugs in urine. Ergogenic drugs carry serious risks. Health care professionals should educate patients about the effects of these drugs and counsel patients not to use them.

Drug use by athletes has become commonplace. Many athletes use performance-enhancing drugs, known as ergogenic drugs, to improve their athletic ability beyond the levels otherwise anticipated. Examples of ergogenic drugs are anabolic steroids, growth hormone, and erythropoietin. Some athletes consider stimulants to be ergogenic because of their ability to mask fatigue. Athletes may also use drugs to aid them in circumventing drug testing.

The media have given much attention to the elite Olympic and collegiate athletes caught using drugs to aid them in competition. In addition to the unethical nature of ergogenic drug use and the possible deleterious effects of these agents, many ergogenic drugs are banned for use by athletes competing in events sanctioned by the International Olympic Committee (IOC) and the National Collegiate Athletic Association (NCAA). One researcher surveyed over 2,200 collegiate athletes at 11 different institutions for anabolic steroid use.[1] The incidence was 6% among male athletes and 1% among female athletes. Athletes in the following sports reported the highest use: football (10%), track and field (4%), basketball (2%), baseball (2%), and tennis (2%). Among international Olympic competitors, positive test results for any drug banned by the IOC decreased from 1,153 (2.45%) in 1988 to 993 (1.13%) in 1992.[2] During the 1992 Olympic Games, the banned drugs most frequently used were anabolic steroids (57.3%), stimulants (22.1%), narcotics (8.1%), diuretics (5.6%), masking agents (1.8%), and beta-blockers (0.96%).

Drug use by athletes is not limited to Olympic or college sports. High school and junior high school athletes are using anabolic steroids at a reported incidence of 1.4% to 10.9%.[3] One researcher found that of over 800 junior high school students, 3.8% reported using anabolic steroids.[4] More alarming are the reasons for their use: to increase muscle strength and size, to prevent and treat sports injuries, to improve sexual performance, to increase sexual organ size, and to improve physical performance. It was also noted that these students lack medical knowledge about the side effects of steroids. The reported incidence of female junior and senior high school students using anabolic steroids is 0.5% to 6.7%.[5,6] This dangerous trend has significance for health care professionals who must be aware of symptoms of ergogenic drug use and educate individuals about the risks of using these drugs.

Ergogenic Drugs

The following discussion focuses on anabolic steroids, growth hormone, erythropoietin, and stimulants. Table 1 lists these and other commonly used drugs and specifies their possible ergogenic effects.

Table 1--Possible Side Effects of Ergogenic Drugs

beta-Agonists (eg, clenbuterol*): increase muscle mass, strength
Erythropoietin: increases endurance
Growth hormone: increases muscle mass, strength†
Stimulants

Amphetamines: increase strength, alertness, endurance

Caffeine: reduces fatigue

Ephedrine: increases alertness

Phenylpropanolamine: increases alertness

Pseudoephedrine: increases alertness

Synthetic testosterone derivatives (eg, anabolic steroids): increase muscle mass, strength
* Not available in the United States.
†Drugs that stimulate endogenous growth hormone are amino acids, beta-blockers, bromocriptine, clonidine, gonadotropin-releasing hormones, levodopa, and vasopressin.

Anabolic Steroids

Anabolic steroids are synthetic derivatives of the male sex hormone testosterone.[7] Some athletes use anabolic steroids to increase lean body mass and strength and to reduce recovery time between workouts. However, controlled studies of the effect of these drugs on muscle strength are difficult to conduct.[8] Some athletes use megadoses of these drugs, sometimes 100 times the normal dose; it is unethical to administer such doses to healthy persons in clinical trials.[9,10] Additionally, the severity of side effects occurring at these doses precludes a truly blinded study. Most data are based on anecdotal evidence, and the results are difficult to interpret.

A review of the literature reveals that these agents may slightly enhance muscle strength in previously trained athletes.[11,12] However, unless anabolic steroids are combined with a high-calorie, high-protein diet and intense weight training, muscle size does not increase.

Anabolic steroids promote tissue growth by stimulating protein synthesis and retarding protein catabolism.[7] They promote messenger RNA synthesis, thereby stimulating synthesis of protein in muscle cells. Besides anabolic, or tissue-building, properties, these agents also have androgenic, or masculinizing, properties. A purely anabolic steroid has not been isolated. Determination of anabolic or androgenic response depends on the location of the cell type, not the nature of the steroid.[13]

During periods of stress and intense training, levels of endogenous cortisol increase significantly, resulting in a negative nitrogen balance and muscle wasting. Anabolic steroids reverse these catabolic effects by displacing cortisol from its receptors, allowing the athlete to continue training at a high level. The athlete needs to maintain a high-protein, high-calorie diet before and during anabolic steroid use, in response to the body's increased ability to synthesize protein and prevent protein breakdown.

Athletes use various techniques for taking anabolic steroids. They often take multiple steroids (both oral and injectable forms), a process dubbed "stacking."[14] Taking the drug in cycles of 6 to 12 weeks, followed by drug-free periods of 6 weeks to several months, a method known as "cycling," allows desaturation of the anabolic steroid receptor and enhances the drug's effectiveness. Dosage is initially low, then raised to a peak and subsequently tapered, a process called "pyramiding."

Most of the information on the adverse effects of anabolic steroids is obtained from patients receiving these drugs for legitimate medical reasons: certain anemias, hereditary angioedema, and certain cases of breast cancer.[7] In these patients, anabolic steroids are found to produce a wide array of adverse effects,[7,9,10,15-17] which may differ from those in the athletes who use extremely large doses. Table 2 lists the side effects of anabolic steroids. Some male athletes

administer other drugs to combat the deleterious effects of anabolic steroids.[18] Gonadotropin-releasing hormones (GnRH), human chorionic gonadotropin (hCG), and menotropins are administered to stimulate the production of endogenous testosterone and maintain testicular function.[19]

Table 2--Side Effects of Anabolic Steroids*

Endocrine and Reproductive

Male

- Decreased levels of reproductive hormones
- Testicular atrophy
- Oligospermia and azoospermia
- Gynecomastia
- Prostatic hypertrophy
- Prostatic carcinoma
- Priapism
- Altered glucose metabolism (insulin resistance, glucose intolerance)
- Altered thyroid profile (decreased T3, T4, TSH, and TBG)

Female

- Masculinization
- Hirsutism
- Deepening of the voice
- Clitoral hypertrophy
- Menstrual irregularities
- Male pattern alopecia
- Altered glucose metabolism (insulin resistance, glucose intolerance)
- Altered thyroid profile (decreased T3, T4, TSH, and TBG)

Cardiovascular and Hematologic

- Decreased HDL cholesterol
- Increased LDL cholesterol
- Hypertension (sodium and water retention)
- Clotting abnormalities
- Myocardial infarction
- Left ventricular hypertrophy
- Cerebrovascular accident

Renal

- Elevated BUN, creatine
- Wilms' tumor

Dermatologic

- Acne
- Alopecia
- Temporal hair recession
- Skin rash

Hepatic

- Elevated liver function test results
- Cholestatic jaundice

Hepatocellular carcinoma (> 24 mo use)
Peliosis hepatis (> 6 mo use)
Hepatoma
Hepatitis

Musculoskeletal

Increased risk of musculotendinous injury
Avascular necrosis of femoral heads
Premature epiphyseal closure (adolescents)

Subjective

Edema
Muscle spasm
Anxiety
Increased urine output
Headaches
Dizziness
Nausea
Euphoria
Urethritis
Scrotal pain
Irritability
Suicide ideation or attempts

Psychological

Aggressive behavior
Mood swings
Increased or decreased libido
Dependency
Acute psychosis
Manic and/or depressive episodes

Miscellaneous

AIDS transmission as a result of needle sharing

*Classified as schedule 3 controlled substances.
BUN = blood urea nitrogen; HDL = high-density lipoprotein; LDL = low-density lipoprotein; T3 = triiodothyronine; T4 = thyroxine;TBG = thyroxine-binding globulin; TSH = thyroid-stimulating hormone.
From Graphery,[17] with permission.

---

beta-*Agonists*

Some long-acting beta-agonists also enhance muscle strength and size. Studies in animals have shown that stimulation of beta-adrenergic receptors increases muscle mass, body weight, and muscle protein synthesis.[20] Clenbuterol, a selective $beta_2$-agonist used for its anabolic effect, has a half-life of 34 hours.[21] It is not available in the United States. Adverse effects of clenbuterol are similar to those of other $beta_2$-agonists: tachycardia, tremor, palpitations, nausea, and decreased serum potassium concentrations.

Growth Hormone

The use of growth hormone escalated dramatically in the late 1980s,[22] when drug testing for anabolic steroids became routine. The use of drugs and nutritional supplements that raise endogenous growth hormone levels also increased. The amino acids arginine, ornithine, and lysine, in combination or alone, may increase levels of

endogenous growth hormone.[19] beta-Blockers, bromocriptine, clonidine, levodopa, and vasopressin also increase its release.[23, 24]

Growth hormone exerts many physiologic effects, primarily the stimulation of somatic growth.[23, 24] A positive nitrogen balance and an overall anabolic effect result from the transportation of amino acids into tissue and subsequent protein synthesis. Additionally, growth hormone stimulates the mobilization of lipids from adipose tissue and increases oxidation as a source of energy, thus sparing muscle glycogen. However, there are no studies to assess the ergogenic effects of growth hormone in athletes.[19]

Reported adverse effects of growth hormone in patients receiving the drug for medicinal purposes include acromegaly, gigantism, glucose intolerance, myopathy, heart disease, arthrosis, hyperlipidemia, muscle weakness, hypothyroidism, and disfigurement associated with bony overgrowth.[23]

Creutzfeldt-Jakob disease, a fatal neurologic disorder with a 15-year incubation period, has also been associated with the use of growth hormone. Until 1985, growth hormone was extracted from cadaver pituitary glands. Some samples were contaminated with the slow-growing virus that causes Creutzfeldt- Jakob disease.[19] Since there was no method to test for the presence of this contaminant, in 1985 human growth hormone was withdrawn from the market. Recombinant growth hormone became available later that year.

Today, athletes' interest in growth hormone is limited by its cost, the need for needles and syringes, and the difficulty in acquiring pure drug.[19,22] Despite this, some athletes still use the hormone, especially since drug testing for this compound is not currently available.

Erythropoietin

Taking erythropoietin and infusing red blood cells, either one's own or a donor's--a process known as "blood doping," elevates the number of red blood cells in the circulation, thereby increasing the oxygen-carrying capacity of the blood and improving endurance.[25] Marathon runners, cyclers, and skiers may gain the greatest benefit. Although there are no studies assessing the ergogenic effect of erythropoietin, its effect on endurance is obvious.

Erythropoietin use is associated with severe adverse effects: hematocrit levels may become dangerously high, making the blood viscous and leading to poor circulation.[26] Thrombosis or myocardial infarction may occur. Recently, its use was suspected in the deaths of four cyclists from the Netherlands.[27] Nevertheless, athletes continue to use erythropoietin because there are no tests to detect its use, and its ergogenic effects are sustained long after administration.[28]

Stimulants

Many types of stimulants are available to the athlete: amphetamines, pseudoephedrine, phenylpropanolamine, ephedrine, and caffeine. Their use may enhance performance by allowing the athlete to feel more alert and delay fatigue brought on by prolonged exertion.[9,24] Stimulants also generate feelings of self-confidence, well-being, and aggression. Athletes who compete in sports in which speed, power, and endurance are necessary, such as running, speed skating, swimming, and cycling, may be most affected.[29] Athletes who compete in sports defined by weight classes, such as boxing, wrestling, horseback riding, and judo, may use them for their anorexic properties.[30]

Most adverse effects of amphetamines are an extension of their pharmacologic action.[9,24,29] Restlessness, dizziness, tremor, irritability, hyperactive reflexes, increased libido, insomnia, confusion, delirium, and hallucinations occur from excessive central nervous system stimulation. Cardiovascular effects include headaches, chills, flushing, palpitations, angina, arrhythmias, hypertension, hypotension, bradycardia, tachycardia, and cardiovascular collapse. Adverse gastrointestinal effects include vomiting, abdominal pain, and decreased appetite.

Some athletes claim that caffeine has an ergogenic effect, while others say it makes exercise easier.[31] Caffeine used before a tough workout may enable the athlete to work harder without perceiving the effort as more intense.[29] The athlete may feel more alert and energetic. In large doses, caffeine has a diuretic effect. One review concluded that caffeine improves performance during prolonged exercise of moderate intensity but not during short-term or incremental exercise of high intensity.[32]

Methods Used to Defeat Drug Testing

Since drug testing became routine, athletes have used various methods to render the testing ineffective. Some athletes switched from anabolic steroids, which are detectable in the urine, to proteins like growth hormone, GnRH, and erythropoietin, which are not. Others administered drugs concomitantly with ergogenic drugs to mask the presence of ergogenic drugs in the urine, dilute the urine, or decrease the excretion of ergogenic drugs. Table 3 lists drugs used to mask the presence of ergogenic drugs and their effects.

Table 3--Effects of Drugs Used to Mask the Presence of Ergogenic Drugs in the Urine

Diuretics: dilute the urine, enable rapid weight loss

Epitestosterone: decreases the ratio of testosterone to epitestosterone
Hormones: decrease the ratio of testosterone to epitestosterone

- Growth hormone
- Menotropins
- Gonadotropin-releasing hormone

Uricosuric drugs: inhibit the excretion of ergogenic drugs

- Phenylbutazone
- Probenecid
- Sulfinpyrazone

Anabolic steroids are detected in the urine through an analysis of the ratio of testosterone to epitestosterone (an epimer of testosterone). In the urine of a normal male, the ratio of testosterone to epitestosterone (T/E ratio) is 6:1. Administration of anabolic steroids decreases levels of epitestosterone[29]; a T/E ratio of 10:1 suggests the presence of anabolic steroids with a high degree of specificity.

To avoid testing positive, some athletes administer agents that decrease the T/E ratio. Epitestosterone (which is available for veterinary use) can be administered for this purpose, either alone or in combination with an injectable testosterone preparation.[33] Side effects are similar to those induced by anabolic steroids. Hormones such as hCG, menotropins, and GnRH can also be used. They stimulate endogenous secretion of both epitestosterone and testosterone[34] and may normalize an elevated T/E ratio. In addition, a hormone such as GnRH is not detectable in the urine and can itself stimulate the secretion of growth hormone.[33,34] The ergogenic benefit of GnRH is short-lived, however, and long-term use is necessary to sustain it.

Another method used by athletes is to dilute the urine by taking diuretics, thereby decreasing the concentration of any ergogenic drug in the urine and reducing the likelihood of drug detection. Diuretics may also decrease weight, which may be advantageous if the athlete is in a sport requiring assignment to a weight class.[32] Side effects of diuretics include headache, nausea, vomiting, dizziness, hypovolemia, muscle cramps, and electrolyte imbalances.

Drugs that inhibit the excretion of many drugs, including anabolic steroids, are also used to defeat drug testing. Uricosuric agents, such as probenecid, phenylbutazone (a veterinary product), and sulfinpyrazone, are used for this purpose.[35]

Potential Solutions

Drug use may be curtailed by routine and unexpected drug testing and by providing education about the use and side effects of these drugs.[6,34] Using self- reporting questionnaires, the NCAA documented a decrease in the use of anabolic steroids, apparently related to drug testing. In 1989, 9.7% of division I football players admitted to using steroids, whereas in 1990, only 5% reported using them; during this same period, a drug screening program was begun.[1]

The benefits of educating athletes to the dangers of ergogenic drugs are more difficult to quantify. The Council on Scientific Affairs of the American Medical Association issued recommendations for ensuring the health of the adolescent athlete, one of which is to provide information about drug-related health hazards.[8,36] Health care professionals can offer specific suggestions (Table 4) to the athletes. Despite the risks associated with the use of ergogenic drugs, many athletes and their coaches continue to perceive them as harmless.

Table 4--Suggestions for the Athlete Considering Drug Use

1. Know the facts about all drugs you take--both prescription and over-the-counter
2. View your body as something to keep safe from harm and free from contamination
3. Think about your plans for the future and your health
4. Go for natural methods that allow you to look good and perform well
5. Enjoy and appreciate your uniqueness; don't ever try to be somebody else
6. When in doubt, check it out with somebody who really cares
7. After considering all possible consequences, have the courage to make a good decision based on healthy practices

From Hough,[8] with permission

Return to Text

Conclusions

Although scientific evidence that drugs aid in athletic performance is controversial and sparse, athletes still use them based on anecdotal information and their belief in the drugs' effectiveness. Athletes may ignore long-term consequences of these drugs and put themselves at risk for severe adverse effects. Health care professionals are in a unique position to educate athletes about potential adverse effects of both prescription and nonprescription drugs and to encourage them to stop using these drugs.

MUSCLE-BUILDING

Do andro, creatine work? 11.09.98

"How can I build muscle, lose fat and boost my performance?" The question has generated hundreds of magazine titles, thousands of Web pages and billions of dollars. Some say it's even become an obsession that drives many people to the point of risking their health in a bid to look "buff."

A few minutes spent browsing a magazine stand or the Internet will show you that there's certainly no shortage of purported answers, complete with photographic "documentation."

Even a recreational athlete whose heroics are limited to an occasional game of hoops, a weekend softball game or a friendly round of golf may find it difficult to resist the seductive messages that promise leaner bodies, bigger muscles and better stamina from the contents of a bottle or pill.

Sales of some supplements received a huge boost when reporters revealed that St. Louis slugger Mark McGwire used the supposed muscle-building substances androstenedione and creatine during his successful bid to break Roger Maris' home run record.

While baseball was likely on the minds of most who followed McGwire as he hit 70 home runs to edge the Chicago Cubs' Sammy Sosa for the new record, others cited McGwire's powerful swing and bulging biceps as proof that performance-enhancing substances work.

According to the Nutrition Business Journal, which provides market research for the dietary supplement industry, U.S. sales of pills, powders, bars and beverages promoted to boost athletic performance reached $1.26 billion in 1997. The market was expected to grow by 6 percent to 10 percent in 1998.

Practice, powder or pills?

McGwire's swing has more to do with his finely honed eye-hand coordination than to popping a pill or a super-drink, according to Edward R. Laskowski, M.D., co-director of the Sports Medicine Center at Mayo Clinic, Rochester, Minn.

"Mark McGwire has all the tools within himself to do what he did," Dr. Laskowski says. "If you ask elite athletes in any sport what they did to get to the top, they often break it down to the basics — training, conditioning and practice.

"Look at Sammy Sosa, he hit 66 home runs and also broke Roger Maris' record without taking androstenedione," says Dr. Laskowski. "And McGwire didn't just all of a sudden hit 70 home runs in a season. He hit more than 50 for each of the last two seasons."

However, Sosa, like McGwire, did use creatine. Both creatine and androstenedione are classified as supplements under the Dietary Supplement and Health Education Act of 1994 and are available over the counter to anyone. Nevertheless, some drug chains and health food outlets are refusing to stock androstenedione because of possible health risks.

Under the act, androstenedione, also called andro, and creatine are not regulated by the Food and Drug Administration and are not subject to the same scientific scrutiny as drugs.

McGwire claims andro is a natural substance and says he plans to keep using it. Major League Baseball officials are taking a hard look at andro and its use. The National Football League, the National Collegiate Athletic Association and the International Olympic Committee already ban andro.

Dr. Laskowski says he's concerned that younger athletes will emulate McGwire and others who use substances of questionable value in a bid to gain a competitive edge.

"I think there's a danger that kids will think: 'If I want to be like him, I'll need to take something.' I think we always tend to look for an external agent as a magic bullet, a magic pill that's going to help us perform. The truth is there isn't any," Dr. Laskowski says.

Androstenedione

Androstenedione was developed by East German researchers who used it beginning in the 1970s in an attempt to boost the performance of Olympic swimmers and other athletes. Andro was introduced commercially in the United States in the mid-1990s. Marketers widely claim that a 100-milligram dose of androstenedione increases the male hormone testosterone by up to 300 percent. The increase, according to marketers, lasts for about 3 hours.

Androstenedione is a precursor hormone in the production of testosterone. Most of the testosterone in men is produced by the testes; it is responsible for facial hair, a lower voice, bigger muscles and other male characteristics. Testosterone also is produced in both men and women by the glands located atop each kidney called the adrenal glands. The adrenals, like the testicles, are part of the endocrine system, which secrete hormones directly into the bloodstream.

Testosterone and other hormones are governed by a feedback system in the body that stimulates the production of a specific hormone when levels fall too low. The same system reduces production when optimal levels are reached. Proponents argue that the body directly converts andro to testosterone. An elevated level of the male hormone allows athletes to train harder and recover more quickly.

Few scientific studies have been done on the use of androstenedione, according to Todd B. Nippoldt, M.D., an endocrinologist at Mayo Clinic, Rochester, Minn. "There's not even an answer to the question: 'What does it do?' There just isn't enough good published research to back up the claims that if you take andro, you'll see a 300 percent increase in testosterone levels."

Androstenedione is naturally found in meat and some plants. But the pills and capsules on the market deliver it in a concentrated form that may carry unwanted consequences.

Indeed. The labels of many andro products warn that androstenedione should not be used by women, anyone under 18 years old, or people suffering from any medical conditions, including diabetes, heart disease, psychological disorders and prostate hypertrophy.

The Association of Professional Team Physicians, composed of team doctors from professional sports teams, has recommended that androstenedione be banned from all competitive sports. According to the group, andro has a chemical structure like that of an anabolic steroid — a usually synthetic drug that functions like testosterone. The governing bodies of virtually all competitive sports ban anabolic steroids.

- Steroids - A close look at a catch-all term

The team physicians say that androstenedione has raised concerns about serious health risks and an "unfair advantage" in competition. They also warn of potential complications such as acne, breast enlargement, liver and heart problems, and personality disorders resulting from andro use.

Creatine

Creatine monohydrate is a compound produced by the body that helps release energy in muscles. Unlike androstenedione, scientific research indicates that creatine can boost short-term bursts of power.

"Most of the research points to improvements like one more repetition on a maximum-weight bench press, or increased speed during cycling sprints of very short duration," says Dr. Laskowski. "Some studies have shown an increase in lean muscle mass with creatine. As a result, we've got this hype of creatine producing steroid-like effects without the side effects."

Creatine helps muscles make and circulate more adenosine triphosphate (ATP), the fuel the body uses for quick, explosive activity of short duration like weightlifting or sprinting. Creatine also reduces energy waste products. As a result, it's purported to enhance performance and decrease fatigue.

A normal liver makes about 2 grams of creatine each day. Creatine also is readily available from meat in your diet. Creatine levels are relatively easily maintained, and muscles can store creatine. The kidneys remove excess levels of the substance, which casts some doubt on whether creatine supplements are of any value to someone who already has a high muscle creatine content.

There also are serious questions concerning long-term use of creatine.

"Whether the kidneys can process that much creatine for a number of years is a prime worry," says Dr. Laskowski. "Creatine occurs naturally in foods, but no one knows what a supplemental dose will do over a long period of time."
In addition, creatine tends to draw water away from the body into muscle cells, which can lead to serious dehydration. Dr. Laskowski says that people using creatine should make sure they drink plenty of water or other fluids.
Another worry, according to Dr. Laskowski, is that like andro, creatine is not classified as a drug, so there are no guarantees of its purity. "It depends on the manufacturer, the place you buy it, things like that," says Dr. Laskowski. "Some studies have found compositions very different than what was supposed to be in the container."

- Dietary supplements - Worrisome contaminants found
- Editor's note - Diet supplements: Use caution

That hasn't stopped some coaches and players from advocating the use of creatine. "We even have kids come in feeling bad because they're not using creatine because other people are," Dr. Laskowski says. "We don't like this overwhelming use. In addition to the risk of long-term side effects, people may substitute it for proper training and think: 'I can get away with practicing a little less because I'm taking creatine.'"
Despite the testimonials to muscle size and strength, there is no evidence that andro, creatine or any other substance enhances athletic performances over what could be attained by practice, training and proper nutrition, Dr. Nippoldt says.
"There's really no data that translates into a performance-type situation," says Dr. Nippoldt. "Hitting a home run certainly requires a lot more than being able to lift 10 pounds more, one more time. There's speed, agility and reflexes. There's absolutely no data that any of these claimed performance-enhancing substances do anything to improve those."

Anabolic Steroids

A Threat to Mind and Body

Are Anabolic Steroids Addictive?

Evidence that megadoses of anabolic steroids can affect the brain and produce mental changes in users poses serious questions about possible addiction to the drugs.
While investigations continue, researchers at Yale University have found that long-term steroids users do experience many of the characteristics of classic addiction: cravings, difficulty in ceasing steroids use and withdrawal symptoms.
Pennsylvania State University researchers studied a group of high school seniors who had developed a psychological, if not physical, dependence on anabolic steroids. Adolescent users exhibit a prime trait of addicts-denial. They tend to overlook or simply ignore the physical dangers and moral implications of taking illegal substances.
Certain delusional behavior that is characteristic of addiction can occur. Some athletes who "bulk up" on anabolic steroids are unaware of body changes that Are obvious to others, experiencing what is sometimes called reverse anorexia.

Supply And Demand: The Black Market

Many users maintain their habit with anabolic steroids acquired through a highly organized black market handling up to $400 million worth of the drugs a year.

Until recently most underground steroids were legitimately manufactured pharmaceuticals that were diverted to the black market through theft and fraudulent prescriptions. More effective law enforcement coupled with greater demand forced black marketers to seek new sources.
Now black-market anabolic steroids are either made overseas and smuggled into the United States or are produced in clandestine laboratories in this country. These counterfeit drugs may present greater health risks because they are manufactured without controls and thus may be impure, mislabeled, or simply bogus.
Sales are made in gyms, health dubs, on campuses, and through the mail. Users report that suppliers may be drug dealers or they may be trainers, physicians, pharmacists, or friends.
It's not hard for users to buy the drugs or to learn how to use them. Many of them rely on an underground manual, a "bible" on steroids that circulates around the country.

Safe-And Healthy-Alternatives

Anabolic steroids may have a reputation for turning a wimp into a winner or a runt into a hulk, but the truth is that it takes a lot more to be a star athlete.
Athletic prowess depends not only on strength and endurance, but on skill and mental acuity. It also depends on diet, rest, overall mental and physical health, and genes. Athletic excellence can be, and is, achieved by millions without reliance on dangerous drugs.

Fighting Back

Testing

The major national and international sports associations enforce their ban against anabolic steroids by periodic testing. Testing, however, is controversial.
Some observers say the tests are not reliable, and even the International Olympic Committees tests, considered to be the most accurate, have been challenged. Athletes can manipulate results with "masking agents" to prevent detection, or they can take anabolic steroids that have calculable detection periods.
Despite the problems, testing remains an important way of monitoring and controlling the abuse of steroids among athletes. Efforts are underway to make testing more accurate.

Treatment

Treatment programs for steroids abusers are just now being developed as more is learned about the habit.
Medical specialists do find persuasion is an important weapon is getting the user off the drug. They attempt to present medical evidence of the damage anabolic steroids can do to the body. One specialist notes that medical tests, such as those that show a lowered sperm count, can motivate male athletes to cease usage.
One health clinic considers the anabolic steroids habit as an addiction and structures treatment around the techniques used in traditional substance abuse programs. It focuses on acute intervention and a long-term follow-up, introducing nonsteroids alternatives that will maintain body fitness as well as self-esteem.

Legislation

Both Federal and State governments have enacted laws and regulations to control anabolic steroids abuse.
In 1988, Congress passed the Anti-Drug Abuse Act, making the distribution or possession of anabolic steroids for nonmedical reasons a Federal offense. Distribution to minors is a prison offense.
In 1990, Congress toughened the laws, passing legislation that classifies anabolic steroids as a controlled substance. The new law also increases penalties for steroids use and trafficking. To halt diversion of anabolic steroids onto the black market, the law imposes strict production and record keeping regulations on pharmaceutical firms.
Over 25 states have passed laws and regulations to control steroids abuse, and many others are considering similar legislation.

Education

Prevention is the best solution to halting the growing abuse of anabolic steroids. The time to educate youngsters is before they become users.
Efforts must not stop there, however. Current users, as well as coaches, trainers, parents, and medical practitioners need to know about the hazards of anabolic steroids. The young need to understand that they are not immortal and that the drugs can harm them. An education campaign must also address the problem of covert approval by some members of the medical and athletic communities that encourages steroids use.
The message needs to be backed up by accurate information and spread by responsible, respected individuals.

"We see ... people not being able to see their lives falling apart, people trying to get Off the drug and not being able to.

-Kenneth Yashkin and Herbert Kleber, Yale University

For Further Information

NIDA Hotline
1-800-662-HELP

Operated by the National Institute on Drug Abuse, this is a confidential information and referral line that directs callers to drug abuse treatment centers in their local community.

NCADI
1-800-729-6686

The National Clearinghouse for Alcohol and Drug Information (NCADI) provides information on all drugs, including alcohol. Free materials on drug abuse are also available. If you wish to write NCADI, the address is P.O. Box 2345, Rockville, MD 20852.

Resources

- American College of Sports Medicine, "Position Stand on The Use of Anabolic/Androgenic Steroids in Sports, " 1984.
- American Osteopathic Academy of Sports Medicine, "Policy Statement and Position Paper: Anabolic/ Androgenic Steroids and Substance Abuse in Sport," May 1989.

- Buckley, W.E.; Yesalis, C.E.; Vicary J.R.; Streit, A; Katz D.L.; Wright, J.E., "Indications of Psychological Dependence Among Anabolic/Androgenic steroids Abusers." Adaptation from a paper, "Anabolic steroids Use: Indications of Habituation Among Adolescents," *Journal of Drug Education*, 1989.
- Carolan, N.J., "The Treatment of the Anabolic steroids Addict," Unpublished paper, 1991.
- Cicero, T.J., and O'Connor, L.H., "Abuse Liability of Anabolic Steroids and Their Possible Role in the Abuse of Alcohol, Morphine and Other Substances," *NIDA Research Monograph 102*, 1990.
- Dyment, P.G., and Goldberg, B., Committee on Sports Medicine, "Anabolic Steroids and the Adolescent Athlete, " *Pediatrics*, January 1989.
- Frankle, M.A., "Anabolic-Androgenic Steroids: A Guide for the Physician," *The Journal of Musculoskeletal Medicine*, November 1989.
- Friedl, K.E., "Reappraisal of the Health Risks Associated with the Use of High Doses of Oral and Injectable Androgenic Steroids' *NIDA Research Monograph 102*, 1990.
- Hecht, A., "Anabolic Steroids: Pumping Trouble," *FDA Consumer*, September 1984.
- International Federation of Bodybuilders, "The Battle Against Steroids Goes On: Position Paper of the I.F.B.B," 1990.
- Kashkin, K.B., and Kleber, H.D., "Hooked on Hormones? An Anabolic Steroid Addiction Hypothesis, " *Journal of the American Medical Association*, December 1989.
- Katz, D.L., and Pope, H.G., "Anabolic/Androgenic Steroid-Induced Mental Status Changes," *NIDA Research Monograph 102*, 1990.
- Kennedy, N., "Steroid Studies: Estimated Percentages of Use," Appendix B of the Research Subcommittee of the Interagency Task Force on Anabolic Steroids, National Institute on Drug Abuse, 1990.
- Lombardo, J.A., "Anabolic/Androgenic Steroids," *NIDA Research Monograph 102*, 1990.
- Miller, R.W., "Athletes and Steroids: Playing a Deadly Game, II *FDA Consumer*, November 1987.
- National Institute on Drug Abuse, "Anabolic Steroids: Is Bigger Better or Just Big Trouble?," *NIDA Notes*, Spring/Summer 1989.
- National Institute on Drug Abuse, "Study of Athletes Shows Aggression and Other Psychiatric Side Effects From Steroid Use, " *NIDA Notes*, Spring/Sunirner 1989.
- Norris, J.A., "FDA Warns: Steroids May Be Hazardous to Your Health," *Schools Without Drugs: The Challenge*, U.S. Department of Education, November 1987.
- Office of Inspector General, U.S. Department of Health and Human Services, "Adolescents and Steroids: A User Perspective," August 1990.
- Office of Inspector General, U.S. Department of Health and Human Services, "Adolescent Steroid Use," 1990.
- Stehhn, D., "For Athletes and Dealers, Black Market Steroids Are Risky Business, " *FDA Consumer*, 1987.
- US. Food and Drug Administration, "The Blackmarketing of Anabolic, Ergogenic and Related Prescription Drugs for Athletic Enhancement: An FDA Overview, " *FDA Consumer*, 1987.
- U.S. General Accounting Office, "Drug Misuse: Anabolic Steroids and Human Growth Hormone" August 1989.
- Yesalis, C.E.; Anderson, W.A.; Buckley, WE.; and Wright, J.E., "Incidence of Non-Medical Use of Anabolic Steroids," *NIDA Research Monograph 102*, 1990

NorAndro

19-Norandrostenedione is basically an androstene molecule with a carbon atom missing in the 19th position. I know, I know you'd have to be a chemistry major to figure that out. Well, to save you the trouble…it's basically this: 19-norandrostenedione is converted by an enzyme (17-beta hydroxysteroid dehydrogenase) into nandrolone in the body's liver.

OVER-THE-COUNTER ANABOLIC STEROIDS, 4-ANDROSTEN-3,17-DIONE, 4-ANDROSTEN-3,17-DIOL, AND 19-NOR-4-ANDROSTEN-3,17-DIONE: EXCRETION STUDIES IN MEN

Victor P. Uralets, *Paul A. Gillette*
Quest Diagnostics, Inc., 7470 Mission Valley Road, San Diego, CA 92108, USA

Recently, in November 1997, in addition to the previous appearance of 4-androsten-3,17-dione (**1**), as a nutritional

supplement, two other anabolic steroids, 4-androsten-3,17-diol (**2**) and 19-nor-4-androsten-3,17-dione (**3**), became legally available over-the-counter in the United States. Their impact on urinary steroid profiles will be presented for males with different patterns of testosterone to epitestosterone (T/E) ratios.

Steroid **2**, being a precursor of testosterone and other androgens, behaves similarly to **1**, causing a brief abnormal increase (100 times) of the major urinary steroids: testosterone, epitestosterone, androsterone, etiocholanolone.

Steroid **2**, like **1**, causes temporary increase of T/E for all but low T/E men. **2** undergoes conversion into numerous specific metabolites as well, especially into 3a- and 3b-ol-4-androsten-17-ones and **1**.

Steroid **3,** converting into nandrolone, appears in urine mainly as 19-norandrosterone and 19-noretiocholanolone, reaching concentrations in the first voids as high as 100,000 ng/mL. After a single oral dose of 50 mg, these remain detectable for at least 7 days and up to 10 days. 19-Nortestosterone and dehydrometabolites are well detectable during the first day of excretion. "Asian" men with low T/E metabolize **3** into the same main products as others do with one exception: 19-nor*epi*testosterone appears in urine as a main intermediate metabolite, whereas for Caucasians 19-nortestosterone is a major.

19-Norandrostenedione 4-ESTREN-3,17-DIONE
19-Norandrosterone 5a-ESTRAN-3a-OL-17-ONE

Editorial

by editor Bruce J. Ketchum

Commentary on anabolic steroid use and the rash of nandrolone positives in sport, as it relates to elite pro triathlete
Spencer Smith's case.

It has been suggested that the use of anabolic steroids by endurance athletes does not work because they will cause the athlete to bulk up, slowing the endurance athlete down. I would like to comment differently on this.
How an athlete responds to anabolic steroid use is very much dependent on the sport and physical activity they participate in. A power/strength/sprint athlete uses a proportionately larger quantity of fast twitch type muscle cells that are more apt to hypertrophy or grow to a greater extent than slow twitch type muscle cells. On the other hand, an endurance athlete recruiting a greater proportion of slow twitch muscle cells that have a lesser ability to grow in size will not experience the same muscle growth.
If you were to experiment to see how anabolic steroid use may affect body composition, you might choose a power athlete, an endurance athlete and a sedentary individual. Put them all on the same anabolic steroid drug regime for six weeks and then evaluate their physical changes.
From what I understand, I predict the power athlete would gain the most strength and body mass, the endurance athlete would experience the greatest endurance gains with little gain in body weight, and the sedentary individual will see no visible changes associated with performance enhancement.
Anabolic steroids are drugs that enhance the athlete's adaptation to physical stresses (stimuli). For endurance athletes that means beneficial oxidative/aerobic changes to muscle tissue, including improved mitochondrial density, increased oxidative enzyme activity and enhanced vascularization. Most anabolic steroids have also been shown scientifically to have at least some erythropoietic properties, meaning they can stimulate red blood cell production much like EPO does. Select anabolic steroids have a very powerful erythropoietic effect while others have very little blood-building properties. It is my understanding that the family of nandrolones have a weak erythropoietic effect.
Anabolic steroid use can also enhance glycogen storage and improve fat use for energy. Steroids may also increase motivation and aggression, both important psychological factors for optimal endurance performance.
With that said, I am by no means implying that Spencer Smith used or uses drugs. I am just spitting out my thoughts on this subject. I think he is innocent. In fact, I believe many of the athletes implicated in the rash of recent nandrolone cases are innocent. Something has occurred recently that has made nandrolone either more present or more visible in the body.
I can only hope that the experts who devise and implement athletic drug testing know the difference between endogenous (made in the body) and exogenous (made outside the body) nandrolone, and that they know with accuracy the natural maximum levels that can be produced by the body. Has their lab testing changed recently that allows them to detect nandrolone with greater accuracy or frequency?

19-norandrostenedione

According to some supplement manufacturers, 19-norandro-stenedione (a common form of the nandrolone-like supplements) is thought to be the closest thing to nandrolone, the technical name for the anabolic steroid, Deca Durabolin. It is a direct precursor to nor-testerone (nandrolone). The reason that Deca is the number one choice for steroid users is because some believe it remains attached to the body's steroid receptor sites longer than any other steroid. This means you can use a minimal amount of the drug and still maintain long term, consistent muscle growth and fat loss. Deca Durabolin does not have the androgenic side effects related to other steroids such as acne, water retention, or gynecomastia. Supplement manufacturers say that their investigations show optimal nortestosterone elevation resulting in muscle growth and strength increases comes from 500 to 750 milligrams per day, with a conversion rate of 5.61%.

More likely the cause is the onset of the nandrolone-type supplements that are now so easily available from most health food stores, both online and retail. Some athletes may be taking these supplements either knowingly or unknowingly in belief that they are taking natural health supplements.

Even if the athlete is not taking any nandrolone-like supplements, they may still be taking in the drug. You only have to take a quick tour around a sub-par supplement manufacturing facility to quickly understand how one supplement - lets say creatine - might get contaminated with the nandrolone-like substance. Let me give you an example.

Simply using a scoop, a worker at one table may be filling one-kilogram containers with powdered creatine monohydrate, the most popular sport supplement today. Just feet away, however, an encapsulating machine may be filling thousands of capsules per minute with 19-norandrostenedione. In both instances, dust from both processes is being spewed into the air - so much so that everyone in the room must where filtered masks.

Could prohormone particles contaminate other sport supplement products enough to cause a positive test? That is something I certainly can't answer. But it does pose a significant question: Are our trusted nutritional sport supplements safe?

I can't imagine the legal consequences if it is proven a supplement company's shoddy manufacturing practices are responsible for the destruction of a high-caliber, professional athlete's career and livelihood.

Do you think your energy drink is safe?

1. Dehennin et al. Urinary excretion of 19-norandrosterone of endogenous origin in man: quantitative analysis by gas chromatography-mass spectrometry. J Chromatogr B Biomed Sci Appl 1999 Jan 22;721(2):301-7

2. Le Bizec, et al. Evidence for the presence of endogenous 19-norandrosterone in human urine. J Chromatogr B Biomed SCI Appl 1999 Feb 19;723(1-2):157-72

3. Naets, The Study of the Mechanisms of Androgen Action on Erythropoiesis. Compt. Rend. 259:3371-3376, 1964.

4. Neff, A Comparison of Androgens for Anemia in Patients on Hemodialysis. N. Eng. J. Med. 304:871-875, 1981.

Related pages:

No Case to Answer on Nandrolone Charge by Spencer Smith
triathlete Spencer Smith's statement on his doping case

Second Spencer Smith Statement from Spencer Smith
a statement given by pro triathlete Spencer Smith regarding his ban to race the World Olympic Distance Triathlon Championships and the Ironman World Championships

Natural presence of nandrolones in human urine

Testosterone: The Good, the Bad, and the Contradictory
by Lane Lenard, PhD
a new study suggests high levels of testosterone are associated with lower blood pressure, reduced risk of heart attacks, improved immune function, and smaller waistlines

The Nandrolone Wars by Jim Ferstle
IOC laboratory scientists, the testers who analyze the urine samples for the presence of banned drugs, are speaking out publicly

Anti-Doping Control Crew shows up for No-Advanced-Notice drug test! by Martha G. Sorensen **GoMartha.com**
pro triathlete Martha Sorensen shares her experience with a surprise doping test

Comments on Drug Cases in Triathlon by Jim Ferstle
commentary on the doping state of triathlon

Berkeley Warns of Possible Dangers of Some Supplements
by Joanne P. Ikeda, MA, RD
Berkeley, concerned about the plethora of dietary supplements being marketed to consumers and the advertising claims being made for these products, has made a warning statement

DHEA and Drug Testing
the latest science: the effect of oral DHEA on the urine T/E ratio in human male volunteers

The Devil's Advocate by Bruce Ketchum
a story about a young road cyclist and the temptations of drug use

Hormone Supplements
DHEA, 4-Androstenedione (4-dione), 5-Androstenediol (5-diol), 4-Androstenediol (4-diol), 19-Nor-4-Androstenedione, 19-Nor-5-Androstenediol, 19-Nor-4-Androstenediol